

# **Notes on Monitoring and Evaluation Plans**

**Working Paper #2**

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## **Notes on Monitoring and Evaluation Plans**

### **Introduction**

Because value pricing is a new and innovative way of dealing with traffic congestion, a new project, such as the one planned in the Minneapolis-St. Paul metropolitan area, will be watched closely by the general public, particular by those who are users of the newly-priced express lanes and the adjacent lanes that are not subject to pricing. The project will also be of great interest to transportation officials and others charged with responding to traffic congestion problems. In addition, information on a new project's effects will be of great interest in cities throughout the United States, and, indeed, throughout the world, where traffic congestion is a growing threat to the economic and social viability of urban life.

To help respond to these many interests, a comprehensive monitoring and evaluation plan must be an essential part of a value pricing program. A monitoring and evaluation plan not only provides the framework within which the many questions and concerns about value pricing can be addressed, it serves as an important management tool through which transportation managers and stakeholders can identify problems, refine policies, and make budget and other decisions.

To supplement and support work already done in thinking about monitoring and evaluation for Minnesota's I-394 Express Lanes project, this document includes summaries of a sample of monitoring and evaluation plans from other value pricing projects, as well as a summary of a section on project evaluation included in the National Academy of Science's Curbing Gridlock, the initial nationwide study of congestion pricing completed in 1994. The intent of this document is not to be original, but merely to pull together these sources of information for consideration by those who are charged with developing of Minnesota's monitoring and evaluation plan. Of course, some of these summaries refer to projects that are quite different from the project being considered in Minnesota (e.g., bridge pricing, areawide pricing), yet they may help stimulate thinking about elements of a monitoring and evaluation plan that might be appropriate for Minnesota. The final section of these "Notes" presents some concluding thoughts on monitoring and evaluation.

### **Monitoring and Evaluation Plan Summaries**

Source: <u>Curbing Gridlock: Peak-Period Fees to Relieve Traffic Congestion</u> , V.1, National Academy of Sciences, Special Report 242, pp. 86-96.
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The NAS study was undertaken at a time when the policy of congestion pricing for roads was in its infancy in the United States. The Committee's views on project evaluation were, therefore, focused on learning more about the potential effects of this new and innovative transportation policy. "Careful and extensive evaluation of early congestion pricing programs is critical to developing a better understanding of the advantages and disadvantages of this policy." (Gridlock, p. 91) The NAS study committee's guidance on project evaluation was centered on responses to a series of major questions about the potential effects of congestion pricing, namely:

- What is the range of travel behavioral responses at different prices?
- How will behavioral changes affect congestion?
- What will the impacts be on different groups (income, gender, geographic area)?
- What will the air quality and energy effects be?
- What will the effects on urban form and development be?
- How do all of the above affect public receptivity and political feasibility?

Travel Behavior – The Committee felt that a particularly important area for evaluation was to obtain information that could be used to guide estimates of how shifts in the timing of trips would affect the total loading on the transport system. Different methods of obtaining such information were discussed:

- The Committee noted that one approach to measuring travel behavior is to collect detailed household travel diaries for some time period (24 hours or 7 days). This was the approach used by the World Bank in evaluating Singapore's road pricing program. It was also used in various personal transportation surveys undertaken by the Census Bureau.
- Travel diary data are expensive to collect, which explains why this method is infrequently used. The Singapore study, for example, collected before and after travel diaries from a sample of 2000 travelers (the "after" survey results were supplemented with less extensive surveys of an additional 10,000 residents). Data collected allowed evaluators to measure changes in overall trip making, mode shifts, and elapsed travel times during the peak, and route shifting.
- Less extensive information about travel behavior can be collected at lower cost through telephone surveys. Either approach (diary or telephone survey) would allow for an estimate of demand elasticity, trips forgone, trip chaining, shifts to other modes, and the use of travel substitutes (e.g., increased telephone use, catalogue ordering, telecommuting).
- The World Bank study of Singapore relied on traffic counts of commercial vehicles, but such data are not likely to address ways in which commercial activity might be affected. The Committee felt that it would be more useful to draw a sample of carriers and business entities dependent on the transport system and collect travel and cost data before and after congestion pricing was put in place.

Effects on Facility Congestion – A fundamental evaluation question raised by the Committee is whether and how much congestion pricing reduces congestion on specific facilities. To get at this question, the Committee suggested:

- Traffic counts and vehicle speeds could be collected by time of day and day of week on tolled and untolled routes. It would be important to develop sufficient trend data to account for external effects on travel behavior (e.g., seasonal and economic effects) and it would be necessary to take repeated measurements of traffic effects over several months or quarters after pricing went into effect. Simple before-and-after surveys would be insufficient to account for external effects on traffic and would not address what the traffic would have been in the absence of the intervention. Data collection is always a benefit/cost

exercise and care must be taken to ensure that data is relevant and worth the cost of collection. Frequency of collection may need to be balanced against cost of collection.

- Automated traffic counts will also not provide measures of changes in vehicle occupancy and in the composition (personal/commercial) of vehicular traffic. Measures of such changes can be inferred from the travel diary data but should be confirmed by visual observations.
- In cases where transit options are available to travelers, shifts to transit can be estimated from travel diaries but should be confirmed with ridership surveys. Observations of sample routes and trips would also provide important information about increased crowding, if any, and effects this might have on speeds. Effects on transit service reliability and frequency should be closely monitored, since this might mitigate adverse effects on the poor.

Effects on Specific Groups – The Committee suggested that a panel survey, in which data would be collected from travel diaries or telephone surveys, would allow addressing equity questions. Data collected should include important household and life-style characteristics: income, residential location, commuting pattern, number of vehicles, number of workers, family size, children's ages, annual travel, and employment type and location.

Environmental and Energy Consequences – Given concerns about potential environmental and energy conservation effects of congestion pricing, Committee members felt that it was necessary to collect data on both travel behavior and actual emissions.

- It was suggested that some estimates that congestion pricing would produce energy and environmental benefits assume a net decline in travel, yet there might be offsetting shifts of traffic to other times. Travel diary data or surveys would provide an assessment of such changes in travel patterns.
- Congestion pricing is assumed to improve the flow of traffic and thereby reduce emissions because of less stop-and-go traffic. Such effects can be inferred from traffic engineering surveys of vehicular flow, but the actual measures of emissions on the road during peak periods would also be important. When individual facilities are tolled, for example, traffic diverted to other routes can increase congestion and emissions on those routes. Committee members suggest use of new technologies, such as a Stedman remote scanning device to measure vehicular emissions from in-use vehicles.

Effects on Urban Form – The Committee agreed that the effects of congestion pricing on urban form are difficult to measure since they are long-term effects that take place over several years, during which time pricing's effects can be "tempered" by other forces. Surveys can be conducted on how businesses "might" react, but these won't tell what the actual reactions will be. [note: ongoing surveys of actual impacts on business receipts, etc. and on location decisions are very important]

Political and Public Receptivity – Opinion surveys can provide valuable insights into a variety of issues, such as privacy concerns. It is important to design sample to capture

those most affected, but also to ensure that the sample is representative of users of the facility.

Source: Report on San Francisco-Oakland Bay Bridge Monitoring and Evaluation Plan, November 10, 1993.

The Bay Bridge Report begins with a statement that the objective of the Monitoring and Evaluation Plan is to “determine the effectiveness” of the congestion pricing strategy in meeting its stated objectives. These objectives are listed as:

- reduce recurring peak period congestion on Bay Bridge, and to reduce congestion spillovers onto other facilities;
- improve air quality by reducing localized carbon monoxide concentrations and regional ozone levels, and to conserve energy by reducing fuel consumption;
- to avoid unfairly impacting any particular user group in the corridor, particularly the economically disadvantaged.

The report then lists key items that will be monitored, evaluated, and “where appropriate, compared before and after implementation of ...pricing...as well as for cases with and without pricing.” The items included are listed below.

Planning and Implementation Process - The planning stage study was designed to examine expected impacts and to determine how pricing strategies could be implemented. The planning phase included collecting baseline data, conducting analyses and presenting findings.

The planning study looked at issues such as:

- Expected short- and long-term effects of various pricing strategies on transport system operations and travel demand, and the resulting effects on traffic volumes by time of day, transit use, ridesharing and use of other transport alternatives.
- Social, economic, environmental, and fuel use impacts of various pricing strategies (particularly effects on congestion, emissions, and fuel consumption).
- The incidence of impacts and equity consequences.
- Mitigation measures to offset any potential adverse impacts on particular groups.
- How peak periods should be defined, including number of different time/toll combinations to be implemented.
- The level of tolls to be levied at different times and for different vehicle types or user groups.
- Whether certain groups would be given discounts or other privileges.
- The amount of revenues likely to be generated, and the uses to which revenues would be put.
- Public attitudes toward congestion and pricing strategies.
- Political acceptability of various pricing strategies.

Regional Economic and Demographic Characteristics and Trends – Data are to be collected on overall regional demographic and economic conditions, land use patterns, transportation networks, fuel prices, auto ownership levels using regional modeling data bases. These data are to serve as “background” data and for use in measuring trends in parts of the region not significantly affected by the demonstration project (to provide a “control.”)

Transportation System Characteristics, Operations, and Performance – This item includes detailed descriptions of the Bay Bridge and its approaches, including changes implemented as part of the demonstration project, as well as descriptions of other key facilities and services, including alternate routes and modes. Data to be collected include:

- Traffic volumes by vehicle type and time of day;
- Traffic composition by time of day, traffic flow characteristics (speed, delay), accidents and incidents, HOV lane use, violations and enforcement, effects of AVI;
- Transit operations and performance (bus, BART, ferry);
- Freight operations and performance;
- Revenue collections and expenditures, bridge tolls and other modes.

Travel Behavior and Incidence of Impacts – This item includes surveys to examine travel behavior and location choices, to explore the distributional consequences of congestion pricing and revenue expenditures, and to study impacts on freight transportation. Data collection covered:

- Passenger travel behavior (disaggregated by income, geographic area, and other key groupings) including route choice, traffic diversion, time of travel, mode choice, destination choices and resulting trip lengths, trip frequencies, and trip chaining. A panel survey of approximately 4000 households was the instrument to be used.
- Auto ownership
- Freight shipper and operator behavior

Environmental Quality and Energy Use – Vehicle emissions and vehicle-related air pollution before and after pricing went into effect were to be the primary focus of attention. Other factors to be considered included greenhouse gas emissions, community impacts and fuel consumption.

Revenues and Finance – This phase of the study was to document toll schedules, waivers or discounts granted, toll revenue collections by time of day, toll collection costs, use of toll revenues, and availability of funds for transportation programs.

Location and Land Use – The long-term and complex nature of this impact category is recognized in the report. Modeling was to be relied on as a key way of estimating these impacts. Panel survey questions about household and workplace choices were to provide input to this phase of the study. Business location/expansion decisions were to be explored through interviews as well as tracking business licenses, building permits, and

business news reports. Local government land use policies and programs influencing location and land use were also to be tracked.

Economic Performance – The report recognizes the difficulty of isolating the effects of congestion pricing on one facility on the overall economy. But it also recognizes the concern of business and local governments about potential economic impacts. Thus, various economic data were to be tracked as part of the study, including employment by industry, retail sales, sales tax revenues, rents, vacancy rates (housing and commercial, by type), construction activity, and other business impacts.

Organizational and Institutional Impacts – A pricing program will involve a large number of public and private organizations. This phase of the study would document staffing and resource requirements for all significantly affected organizations, including activities needed to design and implement pricing. Data would come from interviews and review of budget and workload documents. Requirements for interagency coordination and cooperation were also to be identified.

Public Awareness and Attitudes – This phase of the study covers a major public information and awareness campaign that was launched during the planning phase of the congestion pricing project. It includes documenting information provided to the public, media coverage, and public polling to measure awareness, support, and concerns about congestion pricing and changes over time.

Political Acceptability – The political acceptability of pricing may vary over time as a function of familiarity with the concept, its success or failure in reducing congestion, the use of toll revenues, general economic conditions, and other conditions. This phase of the study will use focus groups, small group interviews, and one-on-one interviews to assess acceptability. Plans were to devote most attention to the planning and early implementation phase, but to continue monitoring political acceptability over time. If it had been implemented, plans were to conduct interviews after pricing had been in effect for several years to determine receptiveness to expanding the coverage of congestion pricing.

Source: “I-15 Congestion Pricing Project Monitoring and Evaluation Services, Phase II Year 2 Overall Report,” Methodology, pp. 14-18. San Diego State University, May 16, 2000.

Central to the San Diego evaluation were two major studies: The Traffic Study and the Attitudinal Panel Study.

- The traffic study monitored and evaluated a wide range of quantitative data on traffic volumes, travel modes, vehicle speeds, travel times, violations, potential changes in air quality and cost of delay.
- The Attitudinal Panel Study was intended to assess travel behavior and attitudes regarding FasTrak. 1,500 individuals were surveyed every six months. Survey participants included: (1) current and former ExpressPass/FasTrak users; (2) other I-15 commuters (carpoolers and solo drivers); and (3) I-8 commuters (representing the control corridor).

- The evaluation also included assessment of business and land use impacts, public acceptance, media response, marketing, and institutional issues.

Focus of Studies - The main focus of project studies is to measure the variety of potential effects of the I-15 pricing project on travel in the I-15 corridor. The following questions were developed to guide the study of these impacts in a systematic way:

- What happened in the I-15 corridor and what simultaneously happened in the I-8 control corridor for the characteristic examined?
- Were changes on I-15 different from changes on I-8?
- Can changes observed on I-15 be attributed to the I-15 pricing project?
- What were the major external conditions, if any, which may have contributed to observed changes on I-15 (or I-8)?

Use of a Control Corridor – The study team felt that controls were necessary to distinguish between the effects of value pricing and the effects of other forces influencing the I-15 corridor, such as fuel prices and regional economic conditions.

- For traffic-related studies, the I-8 control corridor was selected to be as comparable as possible to the study corridor (e.g., serves the same commuter function as the study corridor, same distance from downtown area), but important differences were noted (e.g. no carpool lanes on I-8, traffic conditions generally better on I-8, generally lower socio-economic and educational status of I-8 commuters, more balanced gender distribution of I-8 commuters). It was subsequently found that there were also many more new residential developments in the I-8 corridor over the study period. The report notes that “Ideally, specific changes in the number of building permits issued along each corridor should be studied carefully over time. Such a study was attempted but abandoned, as it was found to be prohibitively expensive and technically very difficult to conduct.”
- For the Attitudinal Panel survey, the Business Study, and the Land Use study, relevant areas along the I-15 corridor and along the I-8 control corridor were established, from which respective travelers, businessmen, and residences were randomly selected.

Data Collection – As shown in Table 1, evaluation data were collected at several points during the study period (at times selected to avoid interference from typical seasonal traffic changes). In addition, historical traffic data were gathered for the 7-year period preceding the study.

**Table 1**  
**Waves of Data Collection**

	<u>Pre-project</u>		<u>Phase I</u> <u>Express Pass</u>		<u>Phase II</u> <u>FasTrak⇔</u>			
	<u>1996</u>		<u>1997</u>		<u>1998</u>		<u>1999</u>	
<u>Study</u>	<u>Spring</u>	<u>Fall</u>	<u>Spring</u>	<u>Fall</u>	<u>Spring</u>	<u>Fall</u>	<u>Spring</u>	<u>Fall</u>
Traffic <sup>1</sup>	✓	✓	✓	✓	✓	✓	✓	✓
Bus		✓	✓	✓	✓	✓	✓	✓
ParkRide	✓		✓	✓	✓	✓	✓	✓
Land Use					✓		✓	
Attitudinal				✓	✓	✓	✓	✓
Business				✓		✓		✓

<sup>1</sup> In addition, historical data covering Spring 1988-Fall 1995 were collected.

The types of data collected included both aggregate traffic data on mode use, distribution of peak travel times, speed and travel time, as well as disaggregate data on individual travel behavior, such as individual's reported mode shifts and changes in departure times, traveler perceptions and attitudes, and perceptions regarding congestion, speeds, travel times and safety. Two types of data were used to allow checking the consistency of findings among individual studies and to provide a better understanding of changes in observed effects from study wave to study wave.

Assessment of Traffic Changes - The traffic study compared changes in traffic characteristics from the pre-project period (Fall 1996) to Phase I (Fall 1997) to evaluate the Express Pass program's effects on traffic. The study then looked at changes from Fall 1997 to the end of the second year of FasTrak operation (Fall 1999) to assess the effects on daily traffic of switching to the transponder-operated program.

- Traffic changes were measured and tests were applied to determine whether observed changes were statistically significant (at the 0.05 level). Changes were measured on the overall corridor level (Express Lanes and main lanes, combined), the Express Lanes, and the Main Lanes. Observed changes were compared to changes in daily traffic volumes in the I-8 control corridor. External factors that could have influenced observed traffic changes in the two corridors were noted in the report.
- Changes in daily carpool volumes and single-occupant vehicle (SOV) traffic were also measured, as were changes in the rate of SOV violations on the Express Lanes.
- In addition, traffic engineers continuously monitored the level of service provided by the Express Lanes, since state law authorizing the Express Lanes requires that free-flow traffic conditions (Level of Service C, or LOS C) be maintained. Of particular importance for the value pricing program, the efficiency of capacity utilization on the Express Lanes was measured by looking at the ratio of traffic

volume during the peak period to the maximum peak-period traffic volume that could be maintained while still assuring LOS C. Traffic changes within the peak period were examined to determine whether peak “spreading” had occurred due to the higher fees during the height of the peak period. Time series data were used to ensure that peak spreading was not due to seasonal influences.

- The traffic study also measured changes in vehicle classification and changes in vehicle occupancy on the I-15 main lanes and I-8. Changes in travel time and delay were observed using a car that moved at the prevailing speed of traffic.

Assessment of Delay Costs and Air Quality Changes - The delay study estimated the value of time lost by commuters as a result of traffic delays during peak periods along a 6-mile section of the I-15 main lanes paralleling the Express Lanes. An estimate was also made for a similar length section of I-8.

- Delay costs were calculated based on the total amount of delay on covered sections as compared to free-flow conditions. Value of time (or willingness to pay to avoid delay) was estimated from household income data based on the assumption that value of time is related to wage rates.
- Estimates of changes in emissions of four main pollutants, volatile organic compounds, nitrogen oxides, particulate matter, and carbon monoxide, were made by modeling changes in related emission factors in grams per mile, average vehicle speeds, total vehicles and occupancy, and roadway length.

Attitudinal Panel Study - The Attitudinal Panel Study was intended to assess changes in travel behavior, attitudes, and perceptions over the life of the project.

- Interviews were held in five waves over the Fall 1997-Fall 1999 period. In each wave, the same questions were asked, and any attrition of the sample was replenished by refreshment samples to keep the sample size unchanged at 1500 respondents.
- Panelists were drawn from three sub-samples: (1) I-15 current and former ExpressPass/FasTrak program participants; (2) other I-15 users (both carpoolers and solo drivers); and (3) a control sample of I-8 commuters (both carpoolers and solo drivers). Because of the importance of monitoring the project’s effects on carpoolers, they were oversampled in the initial wave to ensure adequate representation in later waves.
- Comparisons across waves allowed the study team to identify changes that occurred over the study period, and to apply statistical and analytic techniques to help explain behavioral changes. Standard analysis of variance techniques were used to test whether there were significant differences in responses from I-15 users and the control sample. In the first interview wave cross-sectional data were used for analysis. Time series data were used for subsequent waves.

Source: “Evaluating the Impacts of the SR 91 Variable-Toll Express Lane Facility,” Final Report, Chapter 1.3, p. 8, and various appendices. Ed Sullivan, Principal Investigator, Applied Research and Development Facility, Cal Poly State University, May 1998.

The evaluation study objective was to “develop information and insights towards improved understanding of travelers’ reactions to congestion-based road pricing and to the other innovative features of the SR-91 toll lanes.” The study employed direct observations and surveys of travelers and businesses in a designated study area to achieve this objective. Specific data collection and analysis activities included:

Periodic observations on -

- Traffic conditions at selected sites in study area freeway network and at several control sites distant from the SR-91 toll lanes, including traffic counts, speeds, vehicle type distributions, and vehicle occupancies.
- Traffic volumes on selected ramps and travel times on parallel arterials, intended to measure the amounts of freeway traffic diversion during congested periods.
- Ridership on public transportation services and in organized rideshare programs serving the SR-91 corridor.
- Pertinent background factors which may be related to or influence traffic measurements, including lane closures, accidents and other major incidents, special events, unplanned events, park-and-ride-lot use, and weather.

Surveys covering -

- Trip origins and destinations to measure the demographic characteristics of SR-91 peak-period commuters and their revealed travel behavior, taken both before and about a year after the toll lanes opened.
- Traveler opinions to measure commuters’ views about various innovative features of the toll lanes and associated public policies, tracking possible changes over time
- Opinions of area business representatives to record views about express lanes and their effect on local business.

In addition, traffic operational characteristics were investigated, especially those related to weaving at entrances and exits of express lanes, as well as changes in accident experience.

Collection of Vehicle Type and Occupancy Data – Observations on vehicle types and occupancies were collected monthly at ten sites from March 1994 through June 1997 (the toll lanes opened in December 1995).

- Field personnel counted weekday traffic for three 2-hour time blocks in the AM peak, mid-day, and PM peak periods, and for two 2-hour time blocks in the mornings and afternoons of selected weekend days.
- During most of the study, each site was visited once a month on a designated weekday, and once every three months on a designated weekend day.

- The counts for toll lanes and HOV lanes were taken almost continuously throughout the 2-hour time blocks, and counts for mixed-use lanes were sampled on a lane rotation basis. The counts measured the number of persons in personal vehicles and the number of vehicles of other types.
- Variations in the timing of the AM peak period observations created a problem for the use of AM period data for long-term trend analysis. In addition, substantial commuter traffic, particularly vanpool traffic, is known to move through the corridor earlier than the 6:30 start time for data collection. This caused some bias in occupancy measurements during the AM period. For this reason, PM peak observations were relied on for much of the trend analysis.
- The authors note the technical challenge of observing vehicle occupancy. They note “in particular, due to observation angles, vehicle speeds, tinted windows, and other factors, it is often quite difficult to accurately observe the number of vehicle occupants. They attempted to account for, or minimize, these problems through field crew training and careful selection of observation points.
- Independent vehicle occupancy counts were obtained from five control sites. These sites were part of an ongoing occupancy count program and were conducted in a similar fashion as the study sites. The purpose of using these sites was to help assess the magnitude of any possible regionwide changes in travel behavior (none were detected and the control sites played no role in documenting the findings of the study).
- Information about vehicle occupancies was also obtained in the study’s origin-destination surveys. The questions concerning vehicle occupancies provided additional information on ridesharing behavior of peak-period travelers in the corridor.

Collection and Use of Freeway Counts and Speed Data – The study makes extensive use of data on freeway traffic volumes for mainlines and ramps, as well as volumes observed in HOV lanes located along several study area freeways. All of these data were obtained from loop detectors which are installed at approximately half-mile intervals on the freeway system throughout two of the counties in the study area.

- Where possible (where loop detectors were available), the same sites where observations of vehicle types and occupancies were made were also targeted for traffic volume monitoring.
- Problems were found with loop data, including frequent down time due to roadway construction or other factors, and intermittent obvious incorrect data. Software was written to detect and discard clearly unreasonable data.
- Speed data were obtained from floating cars using tacograph-equipped vehicles operated during peak periods, and from speed estimates based on loop detector data. The tacograph runs are an expensive form of data collection and their coverage is therefore quite limited. Loops provide full coverage, but gaps in coverage due to spacing, faulty loop data problems, and other limitations makes

use for speed detection difficult. A number of approximations and reasonableness assumptions had to be made.

Travel Survey Design and Conduct – The highway user surveys attempted to contact only weekday peak-period travelers in the SR-91 corridor. About half of the surveys were in the AM peak, the other half in the PM peak. Interviews were conducted with drive-alone users, two-person carpools, and three-plus rideshare groups.

- Surveys were conducted in November and early December, 1995 (just prior to opening of the toll lanes), and in Fall, 1996 and Winter 1997 (by which time traffic patterns were expected to have stabilized).
- The road user surveys used a panel approach, with replacement. As many people as possible were included in both the before and after surveys, but only travelers from the 1995 sample who still used the study and control corridors in the 1996 survey, and who could be contacted, were included. About 40% of the original sample dropped out of the panel in the 1996 survey. These were replaced by new subjects.
- Sampling techniques and sample size considerations are discussed further in Appendix 3.7 of the study report

Video Data Collection and Analysis – Video cameras were used to detect any systematic differences in lane change patterns or other observable driving behavior that might be related to the toll lanes. Cameras were placed at the entrances and exits to the toll lanes and at other nearby locations. The video investigation focused on the weaving required to separate legitimate toll lane users from legitimate users of upstream and downstream HOV 2+ and mixed-flow facilities.

- Most video data were collected 6 months after the toll lanes opened. It was assumed that by this time early adjustments to the new lane configurations and signing would have been made.
- Data collection involved (1) measurements of lane changes, by direction, within sample sections roughly 300-400 feet long and (2) observations of unusual driving behavior and noteworthy traffic conflicts in the same sampled sections.
- Video data were also collected from a control site (a section of SR-91 with standard HOV lanes). The report notes that no useful data were collected from the control site because it was subject to severe congestion during the observation period.

Opinion Survey Design and Conduct – Opinion surveys were conducted four times with a subset of the persons selected for the origin-destination surveys. In addition, a mail-out survey of business opinion was conducted. Surveys addressed opinions about travel conditions, variable tolling practices, and other features of the SR-91 facility. A longitudinal panel with replacement was used to track possible changes in opinions over time.

- Survey participants were contacted by telephone after being identified through license plate numbers on vehicles observed traveling on SR-91 during weekday peak hours.
- The basic approach to identifying participants and conducting surveys was identical to that used in the travel surveys described above.
- As with the O-D surveys, to the extent possible a panel approach with replacement was used.
- The mail-out survey to businesses was designed to investigate the degree to which managers encourage the use of ridesharing and/or transit, the perceived effects of the toll lanes on business operations, and related issues. In addition, business managers were asked their opinion on whether market-based road pricing was viewed as reducing costs because of congestion reduction and improved reliability of travel.

Source: “I-15 Managed Lanes Value Pricing Project Planning Study: Volume 3, Monitoring and Evaluation Plan,” Prepared by Wilbur Smith, et. al, for the San Diego Association of Governments, May 2000.

This MEP report characterizes the “recommended evaluation approach” for the Managed Lanes project as a before/after study to measure the impact of introducing a pricing program on a HOV facility on which demand will be managed through both pricing of single-occupant vehicles and provision of HOV capacity.

- The intent is to follow, to the extent possible, the evaluation approach used for the earlier I-15 FasTrak program. Similar data sets will be assembled, comparable data analyses will be used, and comparisons between the two studies will be made.
- The report notes, however, that the managed lanes program contains three basic elements, the pricing element, the bus rapid transit element and the use of movable barriers to manage HOV lane capacity. These three distinct elements, together with the existence of multiple access points, will greatly complicate the evaluation compared to the earlier I-15 project. It should be noted that the evaluation plan is intended to measure the effects of the pricing program and not the success of the other elements of the managed lanes program.
- The report also notes that a few components of the earlier I-15 evaluation are not recommended for use in the managed lanes evaluation. These are the business and land use impact studies and the use of a control corridor. The business and land use studies in the earlier evaluation are complete and additional study in this area is not expected to yield significant additional information. The report notes that control corridors have been useful in some pricing studies and not in others. Given the expense of collecting data for a control corridor, the decision was made to drop the use of a control corridor for this study. However, traffic volume data and other indicators normally collected by the state for other facilities in the region may provide some useful background trend information.

### Guiding Evaluation Principles

The MEP report lists several “guiding principles” to be followed in carrying out the evaluation of the pricing program. According to these principles, the evaluation should:

- Be objective and not influenced by project partners with a stake in the outcome...should be conducted by an independent third party that is not part of the funding, implementing or oversight agencies or their contracts.
- Strive to fulfill Federal, state, and regional needs for measuring project impacts and reporting on results.
- Collect adequate before data and ongoing data at key points in the project, and report project results in a timely fashion to support policy-making on future project phases and fulfill supporting agency requirements.

### Evaluation Objectives

The MEP report lists several evaluation objectives contained in Federal sponsoring agency guidelines and as developed through discussions with key agency staff, elected officials and public interest groups at the State and regional level. The aim of the evaluation is stated as “to gauge fulfillment of these state objectives and explore reasons why they were or were not fulfilled. The objectives are:

- (Federal) Test the concept of Managed Lanes as a new type of HOT lane in terms of implementation, operation, enforcement, costs/revenues, and user acceptance.
- (Federal) Test new pricing structures (skewed per-mile rate) and their impact on travel demand on the Express and General Purpose lanes.
- (Federal) Quantify the effect of value pricing on express lane users, other HOV lane users, and non-users (general public, including other I-15 users) through a sound before and after evaluation of project impacts and outcomes.
- (State/Regional) Test the viability and equity of value pricing in a multiple access environment.
- Optimize peak-period capacity and mobility through the use of moveable barrier technology.
- Test whether allowing solo drivers to use the excess capacity in the managed lanes can help relieve congestion on the “main lanes.”
- Assess impact of funding new transit and HOV improvements on use of transit and HOV facilities.

### Evaluation Approach

In order to assess fulfillment of project objectives, and measure and “explain” project effects, a four-tiered evaluation approach is recommended:

- Measurement of System Impacts-measurement of changes in various transportation performance indicators through before and after analysis. “After” data will be collected in waves so that time series data can be analyzed to determine both before and after changes and changes over the implementation

period.

- Measurement of Utilization-measurement of level and frequency of use and characteristics of toll users. Information on toll use is to be collected on a monthly basis through account information as well as traffic counts. Information on toll user characteristics will be collected through a panel survey “if budget allows.”
- Measurement of Acceptance-attitudes of users, non-users and project stakeholders will be assessed to evaluate issues related to acceptance, equity, and public perception of project success.
- Assessment of Operations-performance of the toll system and managed lanes program will be evaluated in terms of reliability, user perceptions, costs, revenue generation, enforcement, etc.

### Performance Measures

The MEP report recommends several performance measures for use in evaluating system impacts and utilization. They are:

- Level of service - measured by time of day, day of week and month to assess pricing’s ability to maintain target LOS. Four monitoring points called for along corridor.
- Changes in delay, travel time and speed - Observations of these variable on the main lanes (“and possibly the managed lanes”) will be important indicators of the effect of pricing program on general purpose lanes. Analysis will be confounded by opening of new mail lane capacity prior to construction of the managed lane.
- Toll user volumes - toll user volume will be closely monitored to assess the ability of the pricing system to attract the maximum feasible number of SOV toll users without compromising the LOS target threshold. Toll lane use by time of day, day of week and month will be collected and analyzed. Toll/HOV violation rates “could also be included within this measure.”
- Changes in mode split - Changes in mode split among driving alone, carpooling, vanpooling, existing bus service, or the new bus rapid transit, will be measured, either through the use of a panel survey or a before-after survey.
- Changes in vehicle occupancy - based on observations at a given point.
- Changes in vehicle classification - to be captured in the same way as occupancy counts.
- Changes in trip-making – changes in trip time, frequency, length, or route might occur. Changes will be measured for toll users, non-users, HOV users and transit users, either through the use of a panel survey or some other before/after users and non-user survey.
- Changes in park-and-ride use – counts of lot usage by time of day and day of week.
- Changes in emissions – estimates will be based on changes in modes and speeds.

## Data Needs for Before and After Assessment

- The MEP proposes to use existing historical data to provide one “before” data point, but also recommends that data be collected at least one year prior to project implementation. If the recommendation to collect data semi-annually in the “after” period is adopted, then before data should be collected twice in the year prior to project opening. The key is to ensure that before and after data collection schedules account for seasonality and adequate comparisons between the before and after periods.
- The preferred source for both user and nonuser behavior data is a panel survey, but if this is not feasible for budget or other reasons, a survey of randomly sampled users and nonusers could be used.
- System Impact Data – The primary data items for “before” and “after” analysis are traffic volumes and speeds, vehicle occupancy and classification, mode split, and emissions.
  - The MEP proposes to collect data on traffic volumes and speeds, summarized by location, direction, time of day, day of week and month. Traffic speed data should be collected in a way that is comparable with the time/distance studies used in the earlier I-15 study (use of floating car). In the “after” period, speed data can be collected from transponder data in the managed lanes, speed data in the main lanes will need to be collected periodically using the floating car method.
  - Vehicle occupancy in the “before” period can be estimated using traffic counts and FasTrak data, but direct observation is recommended to get a more accurate estimate of occupancy on the HOV lanes. The use of “overpass counts” is planned for estimating vehicle occupancy on the main lanes. Vehicle classification counts should be accomplished at the same times and locations.
  - Mode split data can be collected from panel surveys including toll users and non-users. To allow comparison of modes shares before and after opening of the managed lanes, specific sub-samples should include toll users, carpoolers and vanpoolers, and transit users.
  - Changes in automobile emissions can be calculated using changes in mode, travel time, vehicle type and operating speeds.
- Utilization Data – Utilization data includes counts of various user groups, including toll users, HOV users and transit users. “Before” toll user data will come from active user accounts of the FasTrak users the year prior to opening of the managed lanes. “After” data can be collected using accounts from the managed lanes. Socioeconomic characteristics of toll users will come from user survey data from the panel survey. “Before” data on carpoolers and vanpoolers (frequency of HOV use, origin and destination, life span of HOV formation, mode to access HOV arrangement) will be derived from the HOV sub-sample of the non-user panel survey. Information on transit users will be developed in a similar fashion. Park-and-ride lot use and vehicle occupancy should be assessed the year

before project implementation and during the “after” period.

- Acceptance Data – Public acceptance refers to attitudes of three key groups; users, non-users and stakeholders. User and non-user attitudes are to be captured in the “before” wave of the panel survey taken a year before implementation. Questions of perceived equity can be included in the “before” survey, as can expectations about effects on HOV use and attitudes about alternative modes. A panel survey of toll users will explore “after” perceptions of the benefits of the Managed Lanes program, comparisons with the FasTrak program, reasons for using the managed lanes, and awareness of program objectives. Two waves of the panel survey are to be conducted each year and should correspond to the vehicle occupancy and classification counts. A comparable survey of non-users will also be very important in gauging overall project acceptance. Stakeholder interviews should be conducted prior to beginning of project construction to gauge expectations about impacts and project results. Follow-up stakeholder interviews should be conducted annually after project implementation.
- Operational Data – Operational data to be collected include HOV violation rates and safety statistics. The “after” period assessments will include reviews of the performance and reliability of technology and will examine operational costs and revenue production and use.
- Ongoing Monitoring Activities – During the operational period, ongoing monitoring will include monthly updates on:
  - Traffic volumes and LOS on the managed lanes and main lanes
  - Toll use statistics, including daily usage, average trip length in the toll zone, daily revenue
  - Customer service information, including active accounts, prospective customer inquiries, and complaints
  - Semi-annual violation rates in the Managed Lanes (taken over multiple days by the evaluation contractor)
  - Monthly citation and accident data from the Highway Patrol

Key Assessments – The evaluation will attempt to quantify changes in the key performance measures listed above and will conduct overall assessments of:

- Cost of Delay
- Emissions
- Institutional effects
- Equity
- Technology
- Costs and revenues

Source: “Evaluation Study of Port Authority of New York and New Jersey’s Value Pricing Initiative,” prepared by Jose Holguin-Veras, et al, City College of New York at CUNY, Rutgers University and New York University. Listed at Humphrey Institute’s Value Pricing website at [projects/njeval.pdf](http://projects/njeval.pdf).

The main goal of the proposed evaluation study “is to monitor the impacts of the PANYNJ’s Value Pricing initiative.” (introduction of variable tolls on Hudson River crossings). The three focus areas of the evaluation are to be: (1) Descriptive Analyses - analyses of aggregate changes taking place as a consequence of value pricing (e.g., changes in traffic composition and hourly distribution, changes in the socio-economic profile of users); (2) Behavioral Analyses - structuring an analytical framework to monitor long-term behavioral changes of users resulting from implementation of value pricing; and (3) System-wide Impacts - gaining insight into broader impacts of the value pricing initiative on the overall system including the priced facilities and alternative routes.

#### Descriptive Analyses

In this focus area it is proposed to collect data on socio-economic profiles of users and on the operational aspects of the PANYNJ facilities.

- Socio-economic data will include user income, gender, ethnicity, and travel profiles. A sampling universe will be identified and telephone interviews will be conducted with a random sample of users (a questionnaire designed to gather socio-economic data and travel behavior information will be pilot tested before the telephone survey). “Before” and “after” data gathered from telephone interviews will be used to assess the effects of value pricing on users, acceptance rates and level of penetration of transponder use, travel times, and behavioral responses to price changes.
- Operational data will include traffic volumes by vehicle type and time of day, traffic composition by time of day, traffic counts by toll plaza by time of day, and accidents/incidents. The traffic data will be used to assess the effect of value pricing on the hourly and daily distribution of traffic by vehicle type.
- Based on the socio-economic profiles and before and after traffic conditions, the research team will conduct a descriptive analysis of the impact of value pricing. This analysis will focus on assessing changes in traffic composition during peak and off-peak hours; travel behavioral changes per trip purpose, time period and day of week; vehicle occupancy; and socio-economic profile of users.
- Through the use of stakeholder interviews and focus groups, the descriptive analyses will also include assessment of the “before” and “after” acceptability of value pricing.

#### Behavioral Analyses

Conditions before and after implementation will be quantified and data will be collected in order to track behavioral changes over time.

- The complexity of this task indicates that multiple populations of users need to be targeted, including trips with origins and destinations within the study area (internal to internal), trips with external origins and internal destinations, trips with internal origins and external destinations, and trips with both external origins and destinations (for both passenger and freight trips).
- The panel survey technique is preferred as the method of generating data on travel behavior. Review of the San Diego experience with panel surveys is recommended. Data collected will include vehicle utilization, route choice, car ownership, departure time, mode choice, vehicle occupancy, user perceptions about value pricing and the E-ZPASS system, and user response to dynamic traffic information and pricing.
- A methodological alternative to pure panel surveys is to use Split Panel Surveys, in which a panel and a non-overlapping cross sectional sample are assembled. A sample of key user groups to develop statistically significant results in both the initial and subsequent waves. Concurrently, a subset of the sample will be drawn from the population outside the area of influence of PANYNJ facilities. This subset will play the role of a control sample.
- Because of the importance of freight traffic in this area, a panel of freight users will be selected representing those zones and commercial areas most likely to be affected by value pricing. A control panel from outside the target area will be used for comparative purposes. Data collected from the freight panel will include vehicle utilization, delivery route choice, departure time, shipment size, frequency and user responses to dynamic traffic information and pricing.
- The research team will develop models to estimate the responsiveness of SOV, HOV, and truck traffic to toll price and to analyze relationships between user characteristics and travel behavior. Travel survey questions will also be designed to gain information about user perceptions of value pricing.

#### System-wide Impacts

Traffic simulation models will be used to assess overall congestion impacts on both the priced facility and the alternative routes. In addition to modeling traffic flows on the network, the route and departure time choices of individuals and/or classes of users will be modeled (models will be calibrated using data obtained in data collection step). Travel times will be estimated using the floating car technique and traffic volume data. Simulation models will be used to capture responsiveness of users to various value pricing programs and to estimate congestion levels and travel time savings/losses for before and after conditions. Emissions estimates will be made using FHWA emissions models imbedded in the traffic simulation models.

#### Questions to be Addressed

The methodology section of the evaluation proposal concludes with a preliminary listing of questions to be addressed by the evaluation project:

- Has pricing had any effect on driver behavior?  
If so, what is the nature of the change?  
For passenger transportation:  
Change in departure time?  
Change in route choice?  
Trip curtailment?  
Car pooling? Park and ride use?  
For freight transportation:  
Change in delivery frequency?  
Change in shipment size?  
Change in truck type?
- What behavioral changes take place over the long term?
- Has pricing had any effect on system performance?  
If so, in what way?  
For passenger transportation:  
Reduction in travel time?  
Reduction in “traffic (air?) pollution?”  
Trip curtailment?  
For freight transportation:  
Increase in cost?  
Increase in productivity?

### **Some Concluding Thoughts on Monitoring and Evaluation**

#### **Monitoring and Evaluation Should Play a Central Role**

- The focus of monitoring and evaluation is on measuring project performance and the degree of success in meeting established project goals. As such, the monitoring/evaluation function plays a central role in effective project management. A successful monitoring and evaluation plan should help provide answers to key questions about project accomplishments (or lack thereof). It should support decision-making throughout the process of project development, and it should be a tool through which lessons learned about project consequences, be they successes or failures (or things that could have been done better), can be applied to broader applications.
- A project manager wants several things from a monitoring and evaluation plan. The manager wants to know the extent to which the project is achieving stated goals. The manager certainly wants to know about project successes, but he or she also wants to know what isn't working so well and what can be improved. The manager wants a monitoring and evaluation plan that provides timely information that can both improve project decision-making and facilitate policy development.
- Because of the central role to be played by the monitoring and evaluation plan, its development should be viewed as a process that begins well before the project is implemented and continues throughout the life of the project, and perhaps beyond (post-evaluation). The monitoring and evaluation plan may need to be adjusted or

refined as the project proceeds, but it should be in place and agreed to by project stakeholders well before the project is implemented.

### Project Goals and Measuring Performance

- Perhaps the most critically important function of the pre-project phase of the plan is the formulation of clear and objective (measurable) project goals. Several monitoring and evaluation plans have begun the process of formulating project goals by positing clarifying questions about the project's potential effects. This "brainstorming" step can be a helpful way of ensuring that the monitoring and evaluation plan will provide useful information to project managers, stakeholders, and the interested public. Goal-setting may involve several steps, as broad objectives (reduce corridor congestion) are translated into measurable goals (e.g., reduce traveler delay in the corridor; provide a travel time advantage to express lane travelers).
- Once goals and objectives are agreed to, performance indicators need to be developed and decisions need to be made about what data can be used to provide quantification to those indicators. In moving from goals and objectives to performance indicators it may again be useful to go through a brainstorming step of asking questions about desired project performance, then move to identifying data needs to answer those questions.
- Information needs of project managers should be accounted for, as well as needs of project stakeholders. Information that can help answer questions about operational issues is important (are project resources being used effectively?), as is information about social issues (is the project having different effects by income group, gender). Questions about the extent to which project goals are being achieved will, of course, be extremely important.
- While it is important to collect data needed to provide answers to questions of performance, it is also important not to collect data if it appears that it will have limited relevance in answering key questions. Since data collection is expensive, some effort should be made to focus in on the most relevant data needs and avoid over-collecting.
- Points of comparison are essential for evaluating a project's effects and data collection should be targeted at meeting this need. The comparison might be "before" and "after," but some type of control will be needed to help distinguish between the effects of the project and effects that are external to the project. Control corridors have been used for this purpose, but they are often difficult to find. A control corridor should be as similar as possible to the project corridor. Changes in overriding economic conditions or other forces that may affect the project and control corridor differently need to be recognized. If a control corridor is not used, some other way must be found of isolating the effects of the project (would the observed changes in performance be different if the project had not been carried out).
- Data collection is always a benefit/cost exercise and care must be taken to ensure that data is relevant and worth the cost of collection. Frequency of collection may

need to be balanced against cost of collection. “Before” data provides a baseline against which changes in performance can be measured. Such baseline data may already exist and be relatively inexpensive, but if existing data sets are used, they must be well-suited to the comparison with the project effects. Data that reflect conditions too far ahead of project initiation may not provide a valid comparison with “after” conditions (some change may have taken place prior to project initiation). Some supplemental data collection may be needed to update existing data sets so they provide a valid comparison.

- Some evaluation studies have used both aggregate (i.e., total travel) and disaggregate (individual travel behavior) data to provide checks on consistency of findings and enhance understanding of project effects over time. Panel surveys can be an excellent way of tracking changes in individual travel behavior, attitudes and perceptions about a project. Panel observations can be a useful guide in shaping project development. Some monitoring and evaluation plans have used panel surveys to very good advantage. But panel surveys are expensive and budget choices may have to be made. Telephone and mail-out surveys may be a less expensive “second best.”

#### Feedback and Sounding Boards

- Another important aspect of a project monitoring and evaluation plan is the establishment of a feedback mechanism that will provide information about a project’s effects, accomplishments, and problems to managers, stakeholders, and the public. Some interim reporting guidelines will be established by Federal or State regulation, but more frequent reporting will be necessary to provide project managers with information on a timely basis so they can respond to problems as they arise, or report on project accomplishments as they become known.
- Because of the political sensitivity of value pricing programs, it may be useful to establish a public interest “sounding board” group to serve as a mechanism for the initial presentation of project results to the public. Such a group can also provide feedback to project managers that can help improve and reformulate the monitoring and evaluation plan, or the project itself, as needed.

#### Independence

- Just as it is important to establish objective (measurable) project goals, it is important to have objective (unbiased) project evaluations. Of course each of us has our own biases, and those involved with a project no less than others, whether they are project managers, stakeholders, funding agencies, or project consultants. Each has some stake in the outcome of the project. It may therefore be difficult to find a truly independent evaluator. Still, independent evaluation must be the goal of the monitoring and evaluation plan. Sound transportation policy requires it, and public acceptability demands it. The expectation needs to be that objective evaluations can be achieved through promotion of an atmosphere of learning about project outcomes, spurning of preconceived notions about project benefits and costs (even though we all have them), separating facts from opinions, and critical review of evaluative outputs by a balance of individuals with different views and areas of expertise.